An Imaging System for Satellite Hypervelocity Impact Debris Characterization

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Abstract

This paper discusses the design of an automated imaging system for size characterization of debris produced by the DebriSat hypervelocity impact test. The goal of the DebriSat project is to update satellite breakup models. A representative LEO satellite, DebriSat, was constructed and subjected to a hypervelocity impact test. The impact produced an estimated 85,000 debris fragments. The size distribution of these fragments is required to update the current satellite breakup models.

An automated imaging system was developed for the size characterization of the debris fragments. The system uses images taken from various azimuth and elevation angles around the object to produce a 3D representation of the fragment via a space carving algorithm. The system consists of N point-and-shoot cameras attached to a rigid support structure that defines the elevation angle for each camera. The debris fragment is placed on a turntable that is incrementally rotated to desired azimuth angles. The number of images acquired can be varied based on the desired resolution. Appropriate background and lighting is used for ease of object detection. The system calibration and image acquisition process are automated to result in push-button operations. However, for quality assurance reasons, the system is semi-autonomous by design to ensure operator involvement. This paper describes the imaging system setup, calibration procedure, repeatability analysis, and the results of the debris characterization.